T.N. 7025

# FIELD EVALUATION OF THE PROTOTYPE ECODYNE ROTAHOOD EFFLUENT FILTER

PREPARED BY


F. ENGLER

WASTEWATER TREATMENT SECTION

POLLUTION CONTROL BRANCH

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Acknowledgement

The author would like to thank Mr. N. Hunt of Ecodyne and Mr. G. Wynen of the Burlington Skyway WPCP for their participation and co-operation in this study. Reviews and comments to this report by Messrs. S. A. Black, R. K. Khettry and P. Seto are also greatly appreciated.

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Abstract

The Ecodyne ROTAHOOD filter is a single media continuous flow effluent sand filter of circular segmented design. Since the mechanical concept of operation differs significantly from other operating filters in the Province, an evaluation of the prototype ROTAHOOD filter was carried out in 1979 and 1980 at the request of the Project Co-Ordination Branch.

During the evaluation filter performance was monitored to observe effluent quality, operational aspects and mechanical reliability of the equipment. Results indicated good suspended solids removals at design hydraulic loadings with solids loadings up to twice the design rating.

The filter, as modified during the second phase of the study was able to recover from temporary solids shock overloads without operator intervention. Mechanical difficulties which were only encountered during the first phase of the study were corrected by Ecodyne and will be incorporated into final production designs. The manufacturer will also need to modify the underdrain design to prevent accumulation of solids on the filter plate.

## CONVERSION FACTORS

| Metric Unit | Multiplier | Imperial Unit |
| --- | --- | --- |
| mm | 0.0397 | in |
| m | 3.281 | ft |
| $m^2$ | 10.76 | $ft^2$ |
| L | 0.22 | gal |
| L/s | 13.19 | gpm |
| m/h | 0.341 | $gpm/ft^2$ |
| $L/m^2.d$ | 1.23 | $gpm/ft^2$ |
| $kgSS/m^2.d$ | 4.88 | $lbs/ft^2.d$ |

## 1.0 Introduction

The Ecodyne ROTAHOOD filter is a single media gravity operated filter of circular segmented design. The filter features continuous flow and a full automated backwash cycle. Ecodyne presented the ROTAHOOD design concept to the Ministry in August 1976, but a functional prototype was not available until 1978.

In the fall/winter of 1979/80, Ecodyne and the Wastewater Treatment Section jointly carried out a field evaluation of the prototype ROTAHOOD filter at the Burlington Skyway WPCP. Testing on secondary effluent was carried out in two intensive surveys covering different modes of equipment operation. Filter operations continued for a further three months to determine the long-term mechanical reliability of the filter and to allow for examination of the media after five months of continuous use.

## 2.0 Purpose And Objectives

The purpose of the evaluation was to gather data on the performance of the ROTAHOOD filter that could be used by the Design and Equipment Section to assess the suitability of the filter for Ministry sewage work projects.

The objectives of the evaluation were as follows:

a) To assess the filter's solids removal efficiency by monitoring influent and effluent suspended solids concentration at or near the unit's design flow and at suspended solids loadings ranging up to approximately 200% of design.

b) To observe the filter's ability to recover from shock overloading with suspended solids.

c) To determine filter run lengths and backwash volumes generated.

d) To observe and comment on the mechanical reliability and accuracy of the backwash hood indexing mechanism.

## 3.0 Rotahood Filter Design

### 3.1 General Description Of The ROTAHOOD Filter

The prototype ROTAHOOD filter is a gravity filter designed for installation above ground. Details of the filter are shown in Ecodyne drawing T-22636, attached as Appendix I. According to Ecodyne the ROTAHOOD design is equally suited for above or below grade installation. Conceptually above ground installations would operate with pumped inflow and gravity backwash, whereas below ground installations would operate with gravity inflow and pumped backwash. The unit evaluated during this test was of the pumped inflow/gravity backwash type and is briefly desribed as follows.

The filter (Figure 1) consists of a steel outer tank, 3.66 m in diameter by 3.35 m high. Inside the tank are 16 radially arranged media compartments (Figure 2), 660 mm high extending from the perimeter inwards and terminating at a 1.22 m diameter concentric inner shell. A centrally arranged vertical pivot supports a steel hood sized to cover one filter compartment. Once backwash is initiated, the hood is lowered onto the first compartment for the pre-selected backwash period. After

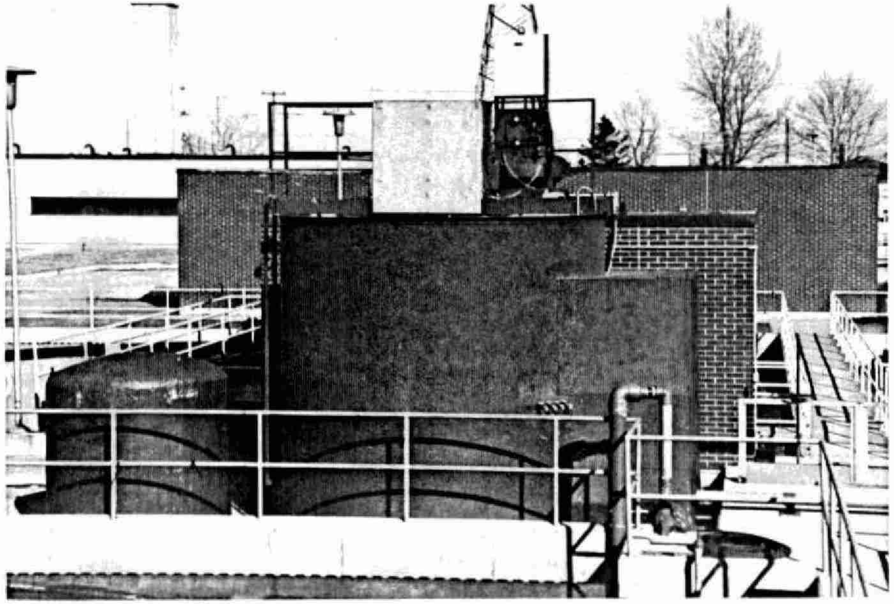


FIG. 1.

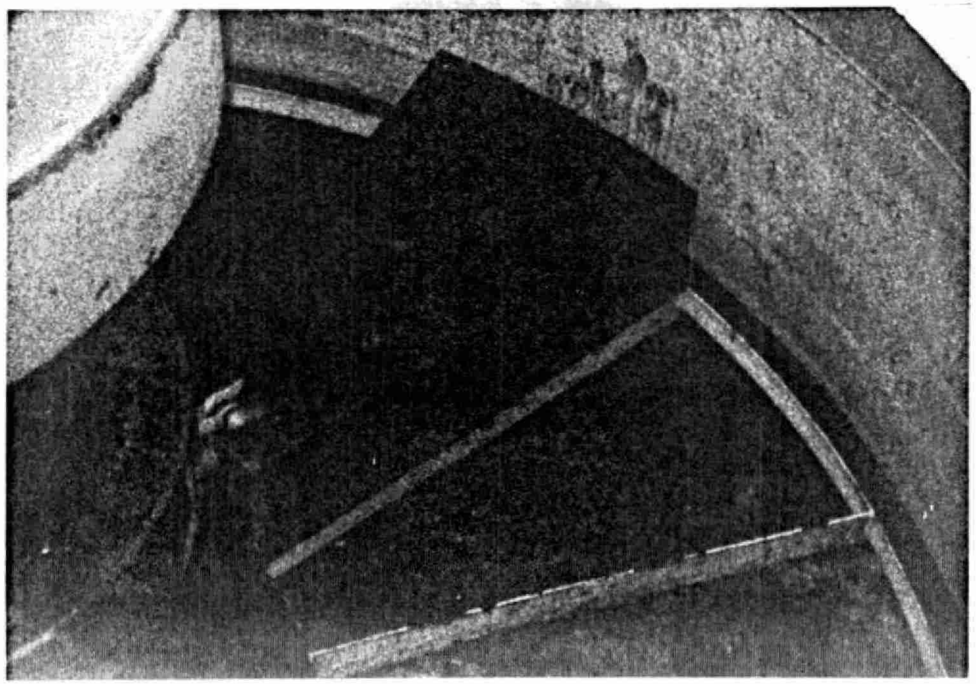


FIG. 2.

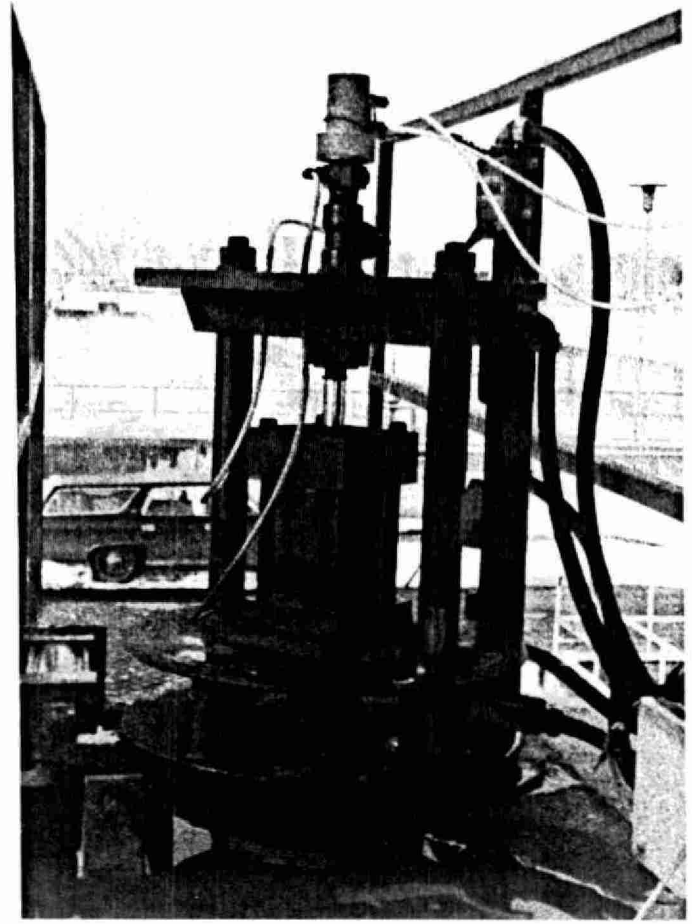


FIG. 3.

FIG 1.: ROTAHOOD filter, general view

FIG 2.: View of filter compartments and backwash hood.

FIG 3.: Hood indexing mechanism.

this period the hood is raised, rotated and lowered in sequence until all compartments have been backwashed. The indexing control mechanism (Figure 3) is mounted on a bridge spanning the top of the outer steel tank. During the backwashing cycle, compartments not being backwashed continue to operate in the filter service mode.

Inflow is pumped to the filter by an integral centrifugal pump. The incoming flow is discharged through a centre well which distributes the flow evenly across the filter, causing the water to pond directly on the media.

The underdrain consists of a 270 mm high false steel bottom equipped with strainers on 200 mm centres. Filtrate collects in the common plenum chamber and is discharged through a 150 mm diameter outlet pipe. For Phase I of the evaluation the discharge arrangement consisted of a pneumatic flow control valve, magnetic flowmeter and effluent piping. For Phase II the flow control valve was removed and a vented stand pipe installed with an elevation of approximately 800 mm above the filter media. This modification was made to simulate the outlet weir Ecodyne intends to use on production filters.

The electrical controls (Figure 4) are housed in a control cabinet (Figure 5) mounted on the bridge spanning the filter. These include:

- backwash interval timer;
- backwash duration timer;
- delay timer for media settling;

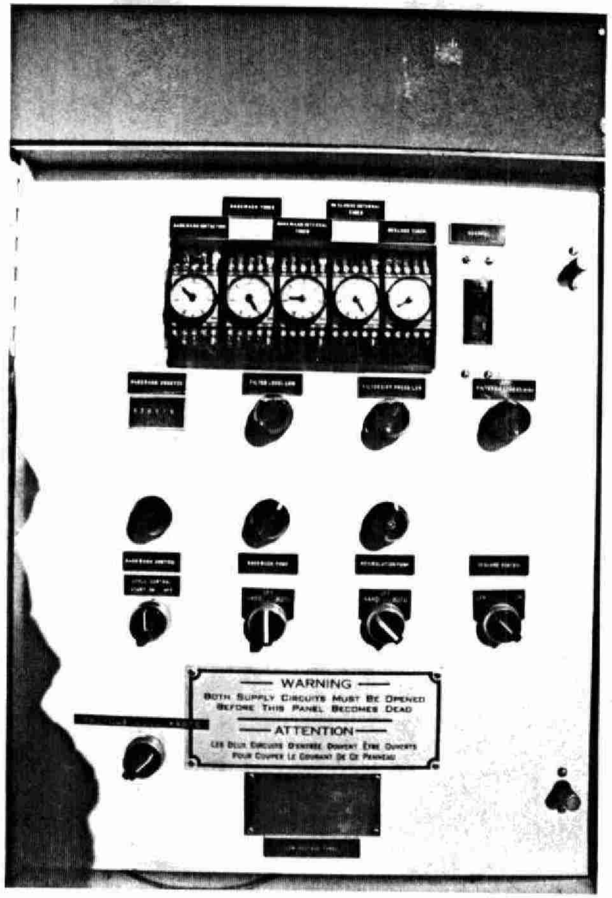



FIG 4.: Filter control panel, showing miscellaneous switches and timers.

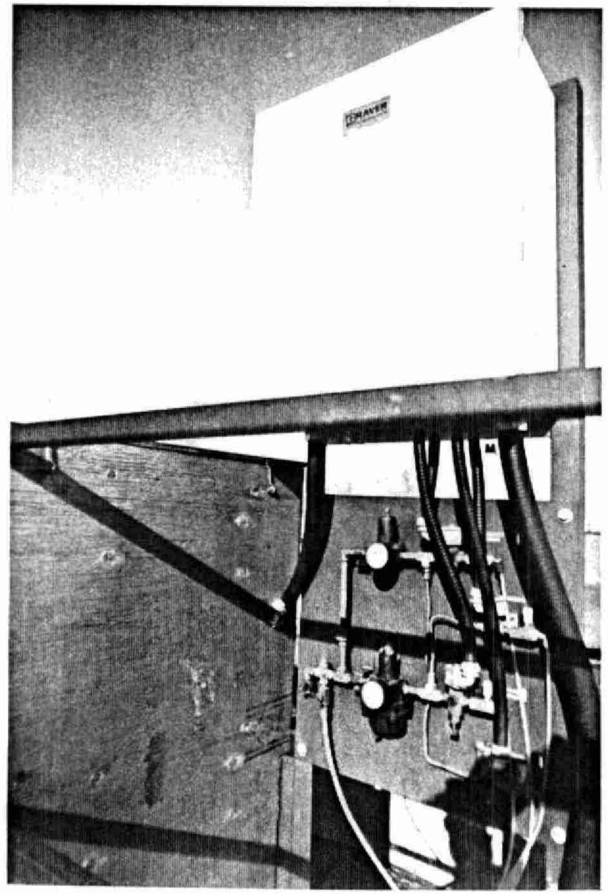


FIG 5.: View of filter control cabinet, index mechanism and pilot valve panel.

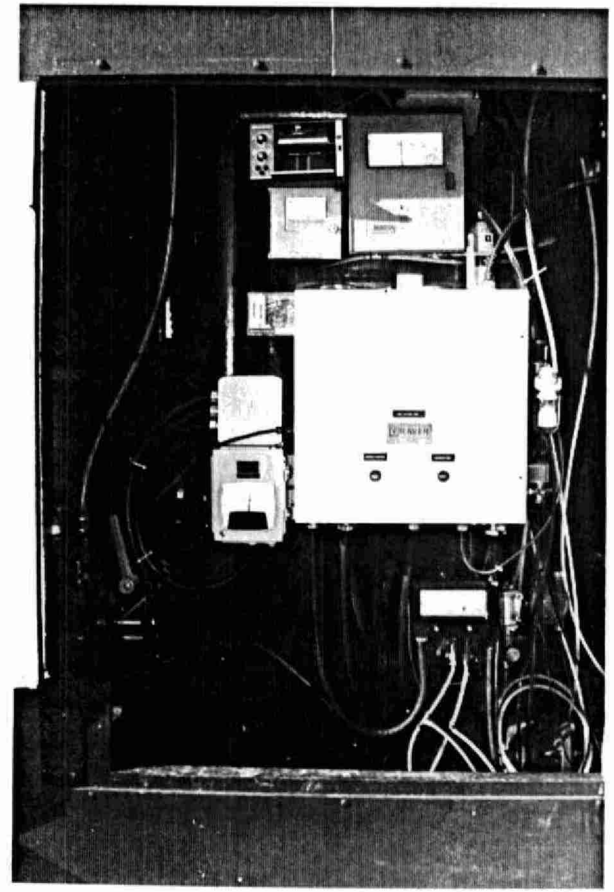


FIG 6.: View of cabinet housing feed pump, filter piping and valving, dP switch, sampling lines etc.

- desludge interval and duration timer;
- backwash mode selector (time, dP, manual);
- main and auxiliary control switches.

All influent/effluent pipes, sampling lines, valves, feed pump and differential pressure switch are mounted on one side of the filter in a large cabinet (Figure 6).

### 3.2 Design Operating Conditions

The filter ratings were originally stated by Ecodyne in US measure. Ratings have been converted to metric units, giving the following design operating conditions:

| | |
|---|---|
| Filter Area | - 9.29 $m^2$ |
| Filter Media Depth | - 400 mm sand, ES 0.45 mm |
| Design Flow | - 12.6 L/s |
| Hydraulic Loading at Average Flow | - 4.9 m/h |
| Suspended Solids Loading | - 3.5 Kg SS/$m^2$.d |
| Length of Backwash Cycle | - 3 min/segment; 48 min total |
| Backwash Flowrate | - 12.2 L/$m^2$.s |

The prototype ROTAHOOD filter was designed for a variety of applications and was built with several features such as backwash recirculation pump and alternate inlet configuration. These items were principally intended to meet potable water treatment requirements, and were not used during this evaluation. The media compartments were built with a depth

of 660 mm; this was done for water filtration purposes. Since the cells were only filled to a depth of 400 mm for the evaluation at hand, the unfilled portion created undesirable dead volume during the backwash, but presented no problem for the filtration process itself.

## 4.0 Operation of the Filter

It was agreed that Ecodyne staff would be responsible for the operation and maintenance of the ROTAHOOD filter during the test runs, whereas Ministry staff would perform sampling and analytical tasks and would provide all necessary monitoring instrumentation and an evaluation report.

### 4.1 Operating Mode, Phase I

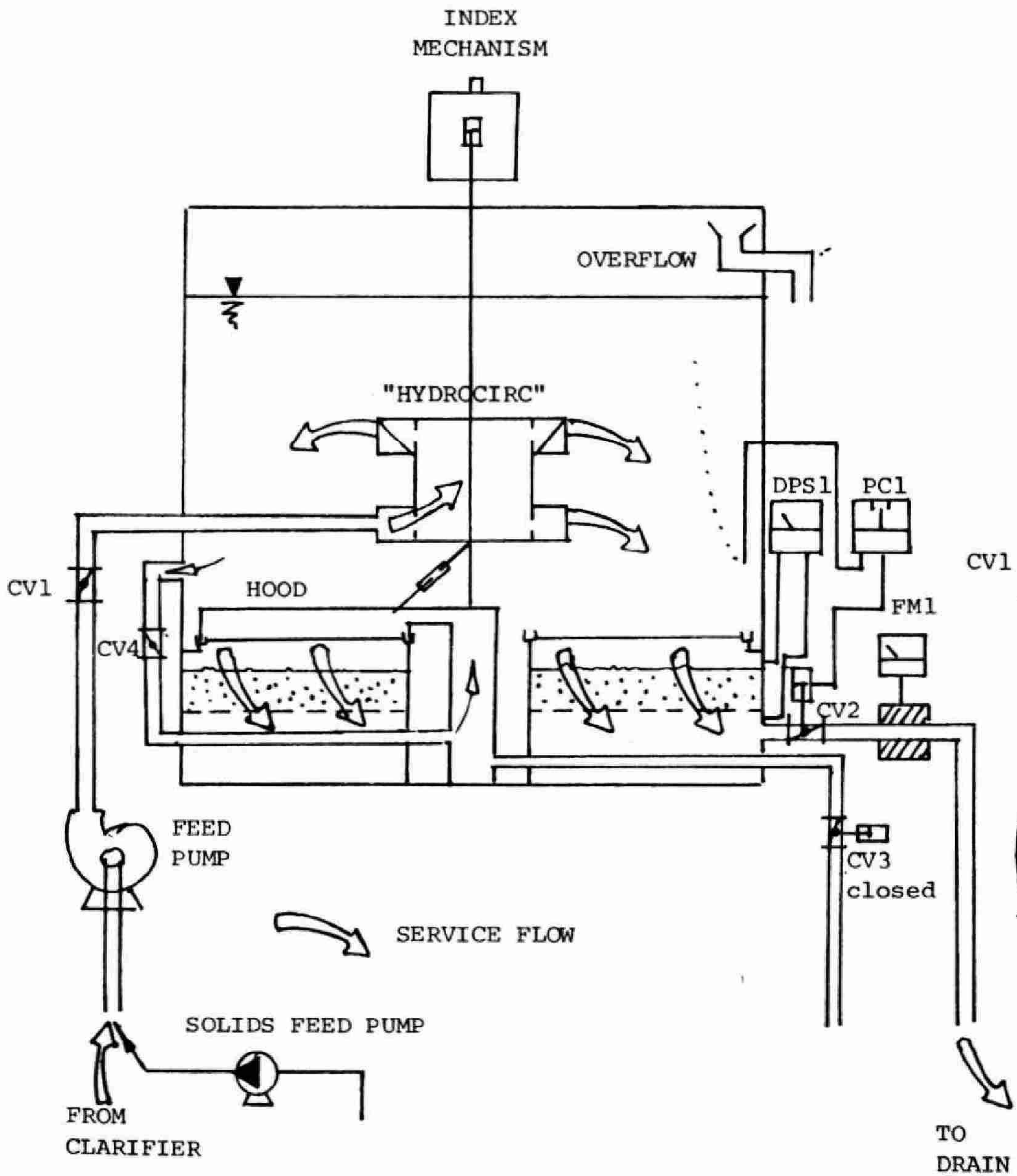
The filter was fed effluent from the #1 secondary clarifier of the Burlington Skyway WPCP. The suspended solids content was quite low, typically 5 mg/L to 10 mg/L. In order to simulate solids loadings approaching the design operating conditions on the filter, a small controlled flow of activated sludge was introduced into the feed pump to raise the suspended solids level to the 30 mg/L to 50 mg/L range.

The flow path through the ROTAHOOD filter in the service and the backwash mode is shown in Figure 7. The flowrate was maintained between 11.7 L/s and 12.0 L/s by manual adjustments. A proportional controller (PC 1) pneumatically positioned the effluent valve (CV 2) to match the incoming flowrate and maintain the liquid level on the media within set limits. Discharge from the filter was measured by magnetic flowmeter (FM 1).

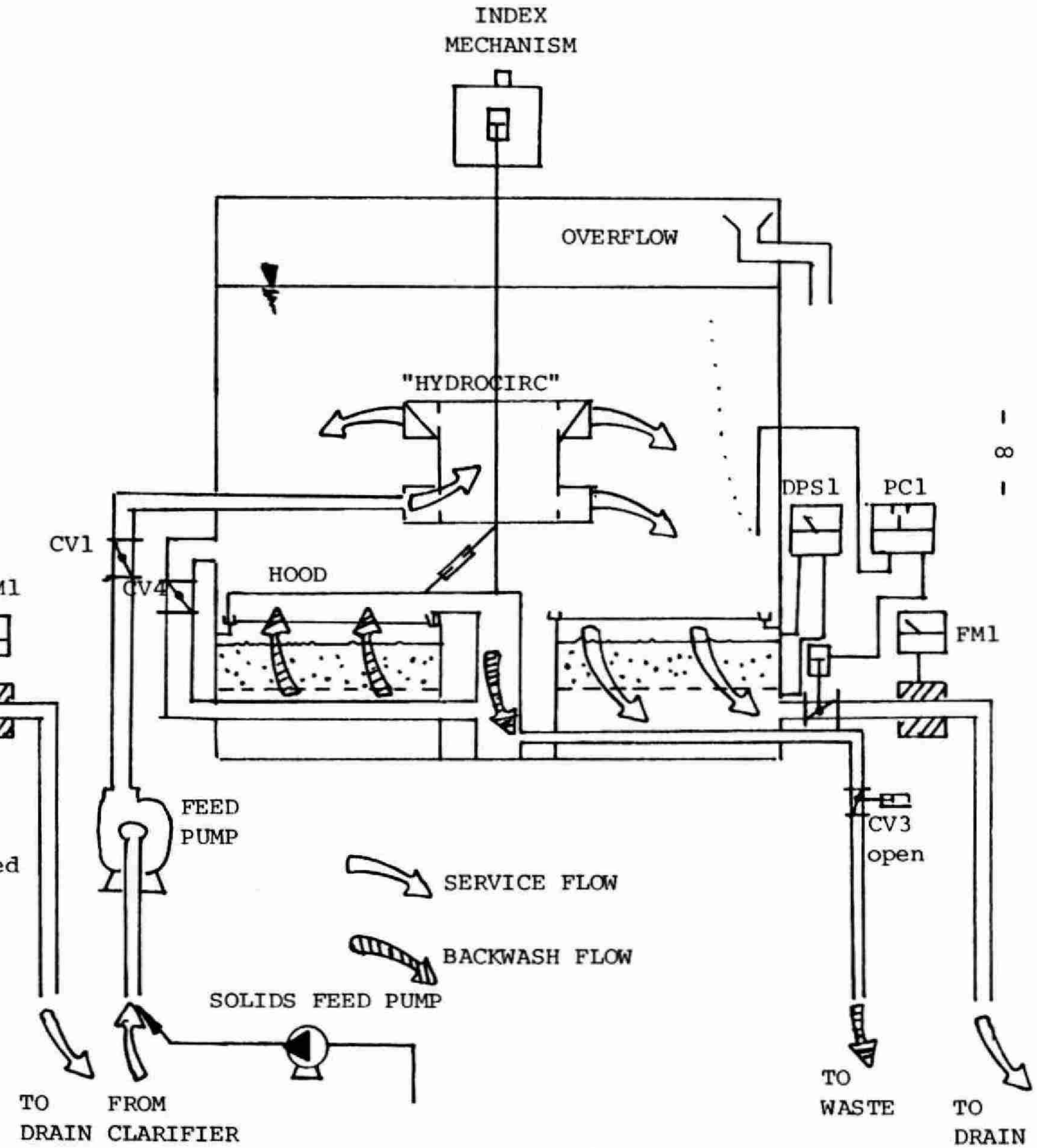
Legend: CV1-CV4, control valves (see text)
PC1, proportional controller
FM1, magnetic flowmeter
DPS1, differential pressure switch

Figure 7: ROTAHOOD filter evaluation, phase I service and backwash flow paths

a) Filter operating in the sevice mode




b) Filter operating in the backwash mode



An indicating differential pressure switch (DPS 1) monitored the head loss across the media. When the preset value of 1,500 millimetres water column (mm wc) had been reached the backwash cycle was initiated.

To backwash, valve CV 4 closed and the hood rotated and lowered onto the first filter compartment. Backwash valve CV 3 opened causing water from the plenum chamber to flow upward through the media into the sealed off compartment and discharge to waste. After 2.5 minutes, valve CV 3 closed and the media was allowed to settle for 0.5 minutes. Then the hood advanced to the next filter compartment repeating the backwash procedure for the remainder of the sixteen compartments. Once the backwash cycle has terminated, valve CV 4 opened, allowing the last compartment to return to service flow.

4.2 Operating Mode, Phase II

The operation of the filter was modified for Phase II of the evaluation based on experiences gained during Phase I. After discussions with the manufacturer, Ecodyne incorporated modifications that would more closely represent final production features of the ROTAHOOD filter.

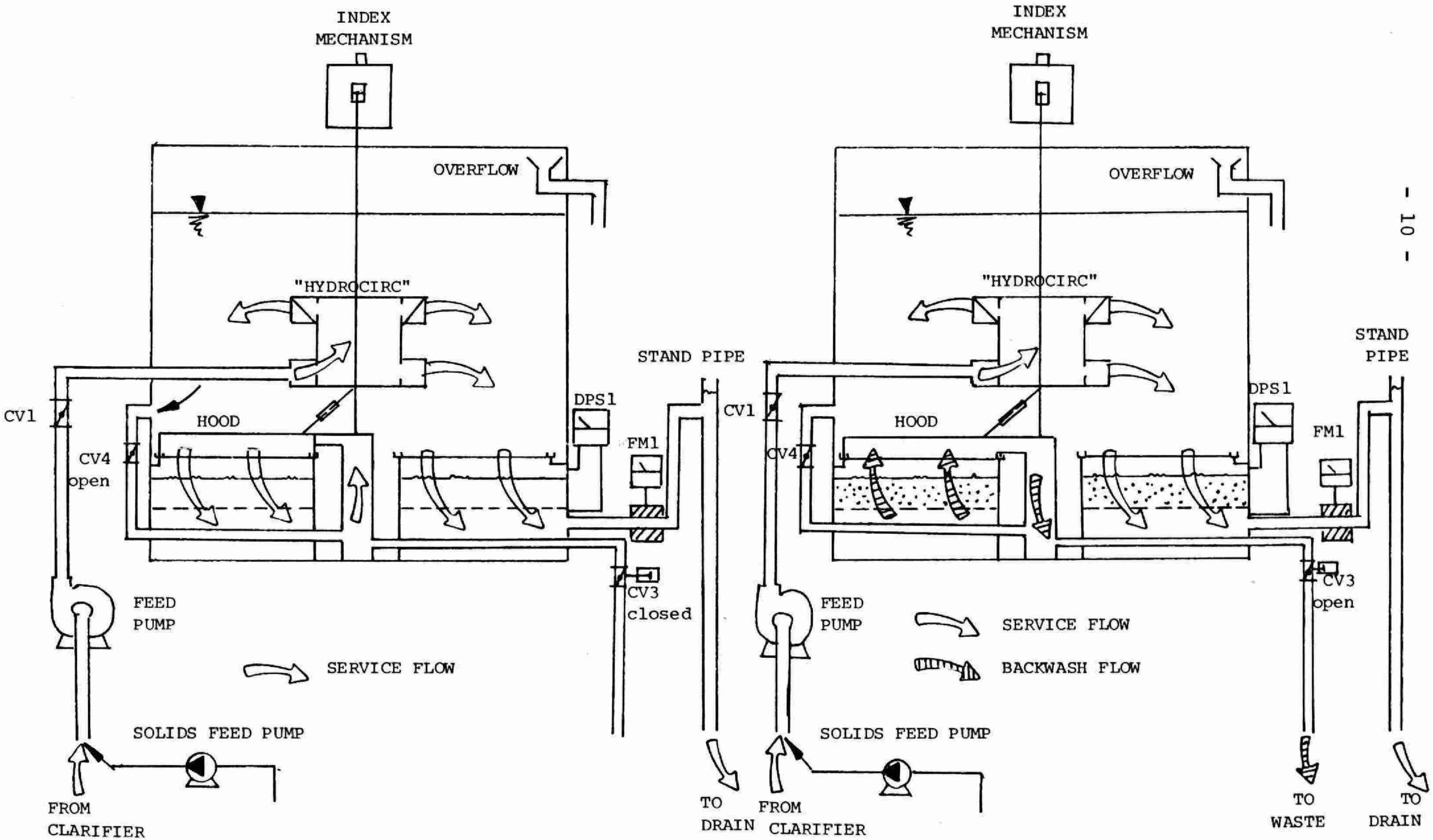
Physical alterations included the removal of the effluent control valve (CV 2) and installation in its place of a vented standpipe elevated 800 mm above the media. This was done to maintain a constant positive pressure in the plenum chamber for backwashing. Figure 8 illustrates the flow path through the filter for Phase II.

Figure 8: ROTAHOOD filter evaluation, phase II service and backwash water flow paths.

Legend: CV1, CV3, CV4, control valves (see text)
FM1, magnetic flowmeter
DPS1, differential pressure switch

a) Filter operating in the service mode

b) Filter operating in the backwash mode



The filter was fed effluent from the #4 secondary clarifier for this phase of the evaluation. This was done because observations during Phase I had shown that the #4 clarifier was less prone to solids carry-over than the #1 clarifier.

The filter service flow was 9.8 L/s for five days and 11.8 L/s for the remainder of the study. Filter flows were measured by a magnetic flowmeter (FM 1) installed in the effluent line.

An indicating differential pressure switch (DPS 1) monitored the media head loss. When a preset value of 750 mm wc* was reached, the backwash cycle was initiated. The sequence of events was the same as already described in Section 4.1.

## 5.0 Results And Discussion

### 5.1 Phase I

#### 5.1.1 Filter Performance

The filter was operated as detailed in Section 4.1 with the influent suspended solids concentration raised between 30 mg/L to 50 mg/L with activated sludge.

Grab samples as well as 24 hour composite samples were taken of the filter influent and effluent. Table I is a summary of the data gathered.

The results in Table I indicate consistently good removal of suspended solids by the filter. The average influent and effluent suspended solids concentrations based on composite samples were 48 mg/L and 1.5 mg/L.

* The value of 750 mm wc is lower than the 1,500 mm wc value used in Phase I due to the presence of the effluent standpipe.

Table I - Summary Of Influent/Effluent Suspended Solids Results For Phase I Of The ROTAHOOD Filter Evaluation

| | COMPOSITE SAMPLE | | SINGLE GRAB SAMPLE | |
|---|---|---|---|---|
| DATE | INFLUENT SS | EFFLUENT SS | INFLUENT SS | EFFLUENT SS |
| DEC. 4/79 | | | 30 | 0.9 |
| DEC. 6/79 | 56 | | 30 | 1.0 |
| DEC. 7/79 | 58 | 2 | 41 | 1 |
| DEC. 10/79 | 51 | < 1 | 34 | < 1 |
| DEC. 11/79 | 41 | 1 | | |
| DEC. 12/79 | | | 26 | 1 |
| DEC. 13/79 | 31 | 2 | 26 | 1 |
| DEC. 14/79 | 40 | | 29 | 1 |
| DEC. 17/79 | 61 | 2 | | |
| DEC. 18/79 | | 1 | | |
| AVERAGE | 48 | 1.5 | 31 | 1 |

It was found that the suspended concentration in influent grab samples taken was consistently lower than the corresponding value in composite samples. This is assumed to be due to the fact that grab samples were taken in the morning when effluent conditions from the activated sludge plant were at their best.

At the flowrates used and suspended solids concentrations observed the filter was operating at an average hydraulic loading of 4.6 m/h or 94% of the design and an average suspended solids loading of 5.3 $Kg/m^2.d$ or 150% of design.

The backwash volume generated by a typical backwash cycle was 8,740 L with the filter operating at 11.8 L/s and influent suspended solids of 30 mg/L. Flow records for 10 hour prior to the test and one hour following the test indicated that the filter was operating on average, 36 minutes in the service mode, followed by 48 minutes in backwash (3 minutes per compartment) for a total cycle time of 84 minutes. At the observed service flowrate of 11.8 L/s the filter processed a total volume of 59,640 L over one cycle, 8,740 L or 14.7% of which went to backwash. Further tests were conducted during Phase II of the evaluation.

5.1.2 Mechanical Reliability

During Phase I there were four occurrences of filter overflows. Two of these were due to equipment problems the others due to shock overloads with suspended solids. The suspended solids concentrations during these shock loadings exceeded 500 mg/L.

December 11, 1979

- Air supply line to indexing mechanism broke; causing filter to plug with solids and overflow;
- After repairs filter required 21 hour continuous backwash to clean media.

<u>December 16, 1979</u>

- Indexing mechanism missed step due to sticking control valve causing filter to plug with solids and overflow;
- After repairs filter returned to normal service in about 2 hours.

<u>December 18, 1979</u>

- Solids loss over weirs in secondary clarifier of 5 hour duration caused filter to plug and overflow for 12 hours;
- Automatic backwash was unable to clear filter; manual resetting of controls was required to return filter to service.

<u>December 19, 1979</u>

- Solids loss over weirs in secondary clarifier of 8 hour duration caused filter to plug and overflow for 15 hours;
- Backwashing could not clear the filter. Filter had to be drained and media cleaned manually.

The mechanical problems observed were caused by cold temperatures affecting the exposed and unprotected filter mechanism and lack of lubricant in the air supply for the pilot valves. As a result, the manufacturer modified the filter to provide a heated protective housing for the indexing mechanism (Figure 1) and regularly serviced the susceptible pilot valves during the Phase II tests.

The problem of filter overflows resulting from shock solids overloads was caused by the ineffectiveness of the backwash action on a plugged filter. In Phase I there was insufficient pressure in the plenum chamber to eliminate heavy solids accumulations from the media. Also, the backwash flowrate was only 6.3 $L/m^2$ or 52% of design. To overcome the difficulties encountered technical alterations to the filter were required.

Based on the experience gained during the Phase I tests Ecodyne modified the filter to the configuration shown in Figure 8 and described in Section 4.2. Phase II of the evaluation was then carried out with the modified filter.

5.2 Phase II

The filter was returned to service after completion of modifications described in Section 4.2. For Phase II of the evaluation several on-line monitors were installed on the filter to document filter performance on a 24 hour basis. These monitors included influent/effluent turbidity recorders and a filter media head loss monitor. Samples were taken by 24 hour composite samplers as well as manually (single daily grab samples).

Results of the evaluation are summarized in Table II and Figure 9. Records produced by the on-line monitors for flow influent/effluent turbidity and media head loss are reproduced in Figures 10, 11 and 12 for three different levels of suspended solids loading to the filter.

5.2.1 Filter Operating At And Above Design Suspended Solids Loading

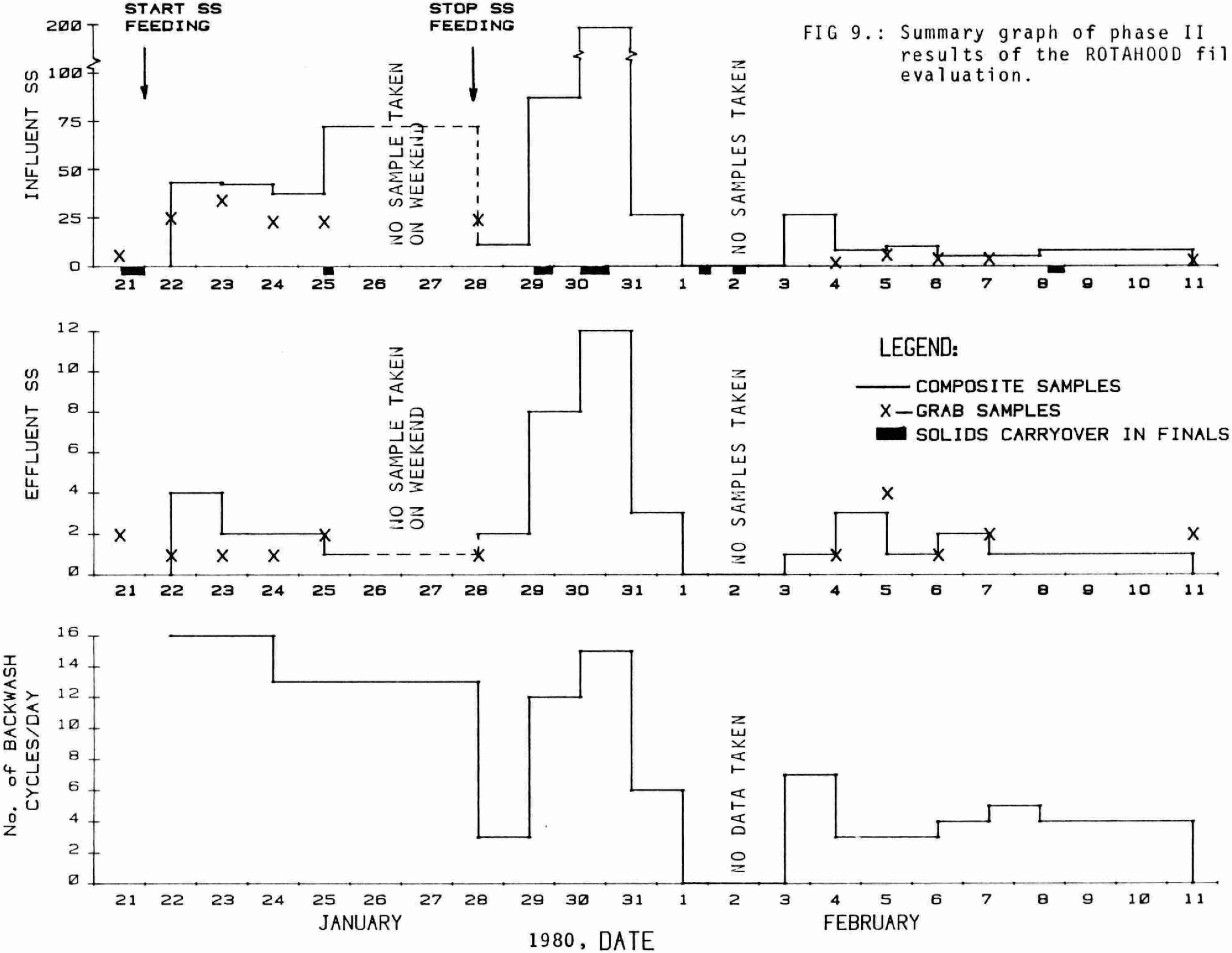
For three days of the test period the ROTAHOOD filter was receiving flow with an influent suspended solids level ranging between 37 mg/L and 72 mg/L. The filter effluent suspended solids for this same period ranged between 1 mg/L and 2 mg/L (Table II). The hydraulic loading was 3.8 m/h or 78% of design; suspended solids loading ranged between 3.4 Kg SS/$m^2$.d and 6.6 Kg SS/$m^2$.d or 97% to 189% of design. At these loadings the filter required 13 to 16 backwash cycles per day (Table II) and generated backwash

TABLE II

Results of Phase II of the ROTAHOOD Filter Evaluation

| Date | Suspended Solids (mg/L) | | | | Flow Rate (L/s) 24 hr. av. | | Backwash Volume | Backwashes | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Composite | | Grab | | | | | Number | Hrs. between | |
| | Infl. | Effl. | Infl. | Effl. | Infl. | Effl. | % of Feed | per Day | Cycles | |
| Jan. 21 | | | 6 | 2 | 9.84 | | | | | Start-up; 10 h clarifier Bulking |
| 22 | | | 25 | 1 | 9.84 | 8.50 | 13.7 | | | Started S.S. Feeding, 10:00 a.m. |
| 23 | 43 | 4 | 34 | 1 | 9.84 | 8.61 | 12.5 | 16 | 1.5 | |
| 24 | 42 | 2 | 23 | 1 | 9.84 | 7.75 | 21.2 | 16 | 1.5 | |
| 25 | 37 | 2 | 23 | 2 | 9.84 | 8.40 | 14.6 | 13 | 1.9 | 3.5 h Clarifier Bulking |
| 28 | 72 | 1 | 24 | 1 | 9.84 | 8.43 | 14.4 | 13 | 1.9 | Stop S.S. Feeding, 2:00 p.m. |
| 29 | 11 | 2 | | | 10.83 | 10.46 | 3.4 | 3 | 7.7 | 7.5 h Clarifier Bulking |
| 30 | 87 | 8 | | | 10.83 | 8.36 | 22.9 | 12 | 2.1 | 11.5 h Clarifier Bulking |
| 31 | 193 | 12 | | | 10.83 | 6.52 | 39.9 | 15 | 1.6 | |
| Feb. 1 | 26 | 3 | | | 10.83 | 9.95 | 8.1 | 6 | 4.0 | 2.3 h Clarifier Bulking |
| 2 | | | | | 10.83 | | | | | 5.0 h Clarifier Bulking |
| 4 | 26 | 1 | 2 | 1 | 10.82 | 9.75 | 10.0 | 7 | 3.4 | |
| 5 | 8 | 3 | 6 | 4 | 10.83 | 9.59 | 11.4 | 3 | 7.8 | |
| 6 | 10 | 1 | 4 | 1 | 10.83 | 10.50 | 3.1 | 3 | 8.0 | |
| 7 | 5 | 2 | 4 | 2 | 10.83 | 10.35 | 4.5 | 4 | 6.0 | |
| 8 | 5 | 1 | | | 10.83 | 10.56 | 2.6 | 5 | 4.6 | 3.0 h Clarifier Bulking |
| 11 | 8 | 1 | 3 | 2 | 10.83 | 10.54 | 2.7 | 4 | 6.3 | Stop Monitoring Program |

FIG 9.: Summary graph of phase II results of the ROTAHOOD filter evaluation.



volumes constituting between 12.5% to 21.2% of the total service flow. Figure 10 illustrates typical filter performance. Influent turbidity (Figure 10B) remained relatively constant; as did the effluent turbidity (Figure 10C). The filter flow ranged between 7.3 L/s and 9.7 L/s (Figure 10A) during the service cycle with lower flows occurring just after the backwash cycles when the water level in the filter was at its lowest. The head loss across the media was 325 mm wc with a clean filter, increasing to 800 mm wc at the onset of the backwash cycle (Figure 10D).

### 5.2.2 Filter Operating At Low Suspended Solids Loading

For seven days during the test period the suspended solids feed pump was shut off and the ROTAHOOD filter operated on straight secondary effluent. The quality of secondary effluent was good over this period, ranging from 5 mg/L to 10 mg/L suspended solids (Table II). The corresponding suspended solids concentration in the filter effluent ranged from 1 mg/L to 3 mg/L. The hydraulic loading of the filter was 4.2 m/h or 86% of design and the suspended solids loading 0.5 to 1.0 Kg SS/$m^2$.d or 14.5% to 29% design. At these loadings the filter backwashed only 3 to 5 times per day, generating backwash volumes of 2.6% to 11.4% of the total filter throughput (Table II).

Figure 10

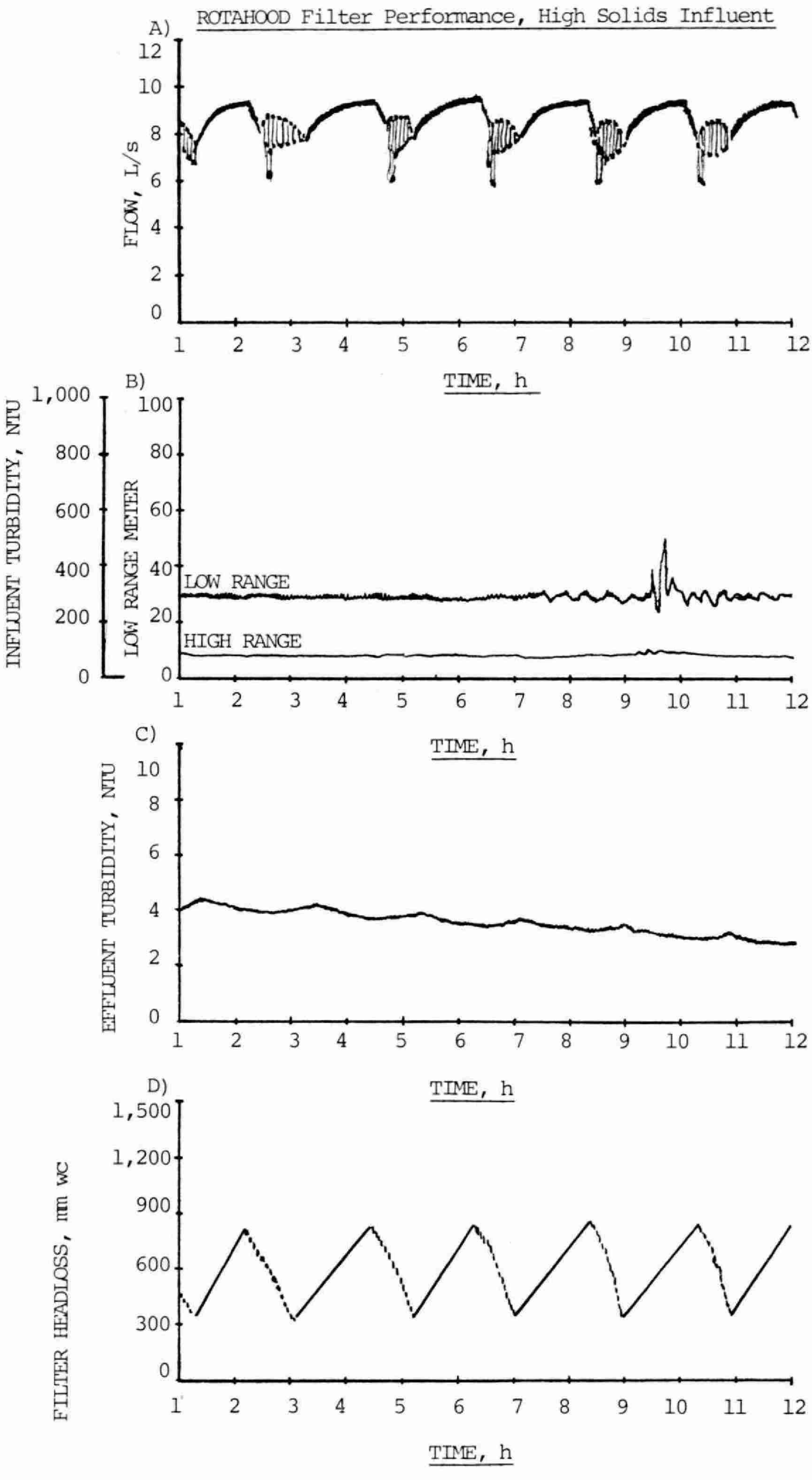

ROTAHOOD Filter Performance, High Solids Influent
A)
FLOW, L/s
0
2
4
6
8
10
12
TIME, h
1 2 3 4 5 6 7 8 9 10 11 12
B)
INFLUENT TURBIDITY, NTU
0
200
400
600
800
1,000
LOW RANGE METER
0
20
40
60
80
100
LOW RANGE
HIGH RANGE
TIME, h
C)
EFFLUENT TURBIDITY, NTU
0
2
4
6
8
10
TIME, h
D)
FILTER HEADLOSS, mm wc
0
300
600
900
1,200
1,500
TIME, h

Figure 11 shows a period of typical filter performance at low suspended solids loadings. Service flow was 9.8 L/s to 11 L/s except immediately after bachwashing when the water level on the filter was low and service flow dipped to about 7 L/s. Influent turbidities were less than 10 NTU. The effluent turbidity trace showed levels higher than expected; this was found to be due to fouling of the monitor's optical surfaces and not due to actual high suspended solids levels. Cleaning the sensor restored the readings to expected levels. The filter had a clean bed head loss of 225 mm wc which increased to 760 mm wc at the onset of the backwash cycle.

### 5.2.3 Filter Operating Under Conditions Of Suspended Solids Shock Overloads

During Phase II there were seven incidents of activated sludge solids overflowing from the secondary clarifier and entering the filter. The length of these events ranged from 2.4 h to 11.5 h, causing the filter to blind and overflow. The resultant headloss across the media placed the filter into a continuous backwash mode which lasted until solids overflow in the secondary clarifier stopped and backwashing had effectively cleaned the media. Figure 12 is a record of a typical event of this nature for the onset of solids overflow to recovery of the filter to normal operation. Figure 12B shows the sudden increase in influent turbidity to about 800 NTU (equivalent to about 500 mg/L suspended solids) and the immediate drop in filter effluent flow rate. Figure 12C shows the accompanying deterioration of filter effluent quality over the duration of the period of solids overload. The head loss across the media can be seen to be considerably higher than under normal operating conditions exceeding 1,520 mm wc for some period of time (Figure 12D).

FIGURE 11

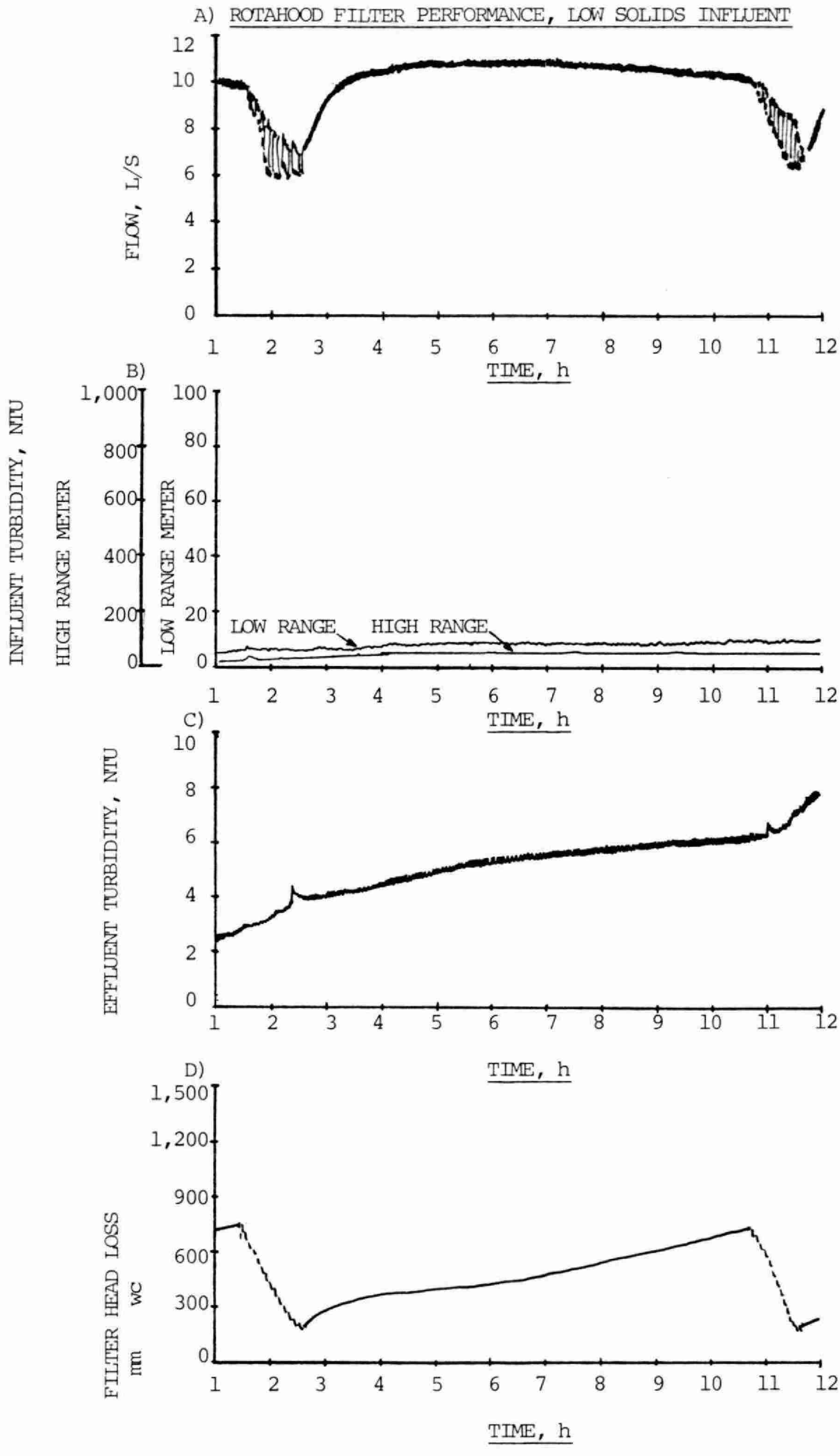
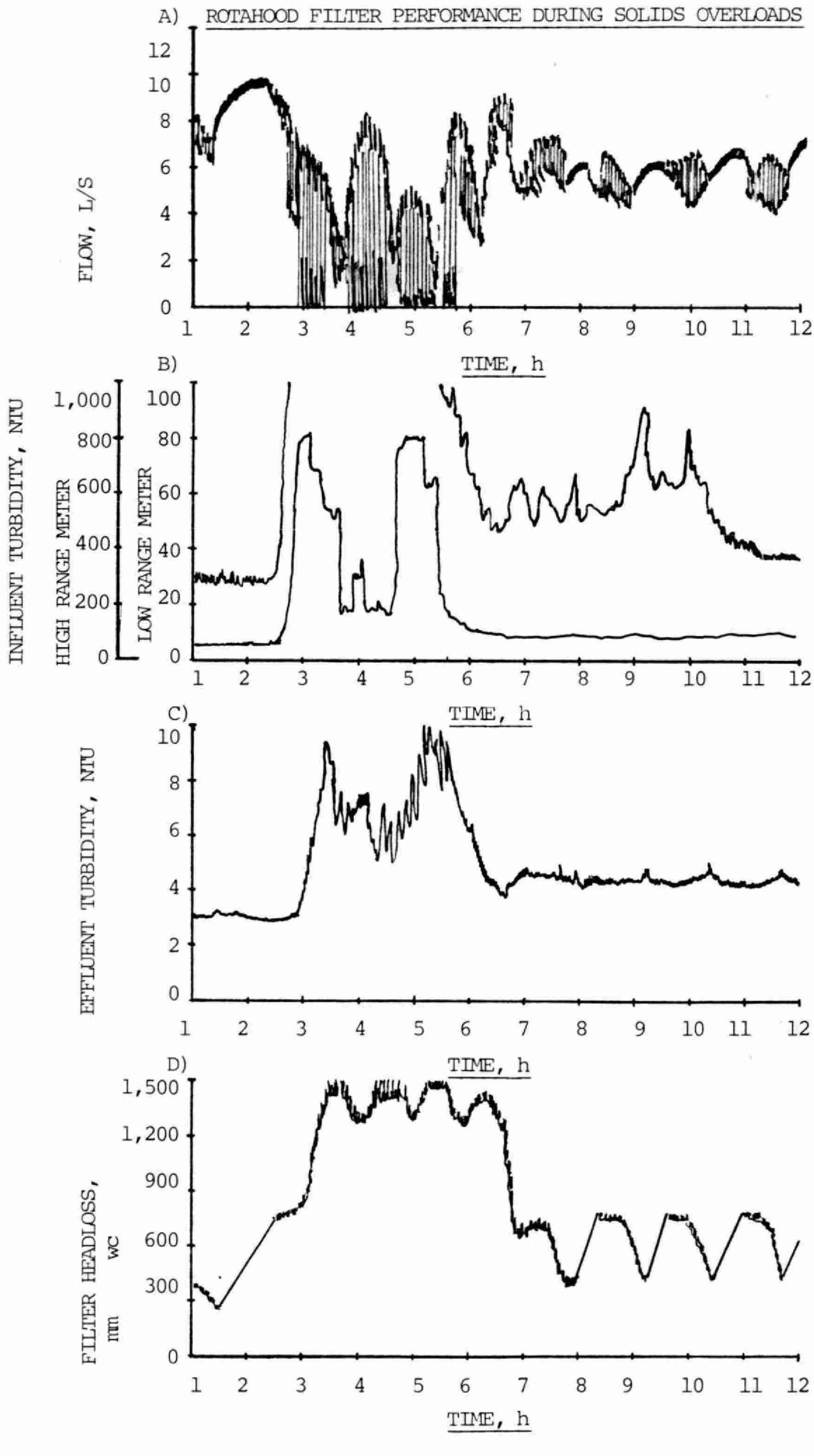

A) ROTAHOOD FILTER PERFORMANCE, LOW SOLIDS INFLUENT
FLOW, L/S
TIME, h
B)
INFLUENT TURBIDITY, NTU
HIGH RANGE METER
LOW RANGE METER
LOW RANGE
HIGH RANGE
TIME, h
C)
EFFLUENT TURBIDITY, NTU
TIME, h
D)
FILTER HEAD LOSS mm WC
TIME, h

FIGURE 12


A) ROTAHOOD FILTER PERFORMANCE DURING SOLIDS OVERLOADS
FLOW, L/S
0
2
4
6
8
10
12
1 2 3 4 5 6 7 8 9 10 11 12
TIME, h
B)
INFLUENT TURBIDITY, NTU
HIGH RANGE METER
LOW RANGE METER
0 200 400 600 800 1,000
0 20 40 60 80 100
1 2 3 4 5 6 7 8 9 10 11 12
TIME, h
C)
EFFLUENT TURBIDITY, NTU
0 2 4 6 8 10
1 2 3 4 5 6 7 8 9 10 11 12
TIME, h
D)
FILTER HEADLOSS, mm WC
0 300 600 900 1,200 1,500
1 2 3 4 5 6 7 8 9 10 11 12
TIME, h

Once the solids overload ceased, the filter returned to normal operation without operator assistance. The time required for the filter to restore head loss to pre-overload conditions was 2 to 3 backwash cycles after termination of the solids overload.

### 5.2.4 Effectiveness Of Backwash

On three occasions grab samples of the backwash water were taken at 15 s intervals during the backwash of individual filter compartments. Results shown in Figure 13 show peak suspended solids concentration was reached after 45 s and solids washout was complete after 150 s. The initial 15 s lag in the suspended solids concentration was probably caused by the "dead volume" above the media in the filter compartments and in the hood itself (see also Section 3.2). The dead volume is about 280 L per filter segment or 4,480 L for the filter. This constituted 51% of the backwash volume per filter cycle during Phase II. On production filters Ecodyne would lower the filter compartment depth and redesign the hood to minimize the dead volume and thereby reduce backwash water requirements.

On examination of the media during a filter shutdown and at the end of the filter evaluation, fines were found to have accumulated in the areas between the backwash strainers (see also Section 5.3.3). Backwash action presumably was unable to eliminate solids accumulated in these areas.

### 5.2.5 Mechanical Reliability

No mechanical problems were encountered with the ROTAHOOD filter during the Phase II tests.

# ROTAHOOD FILTER BACKWASH

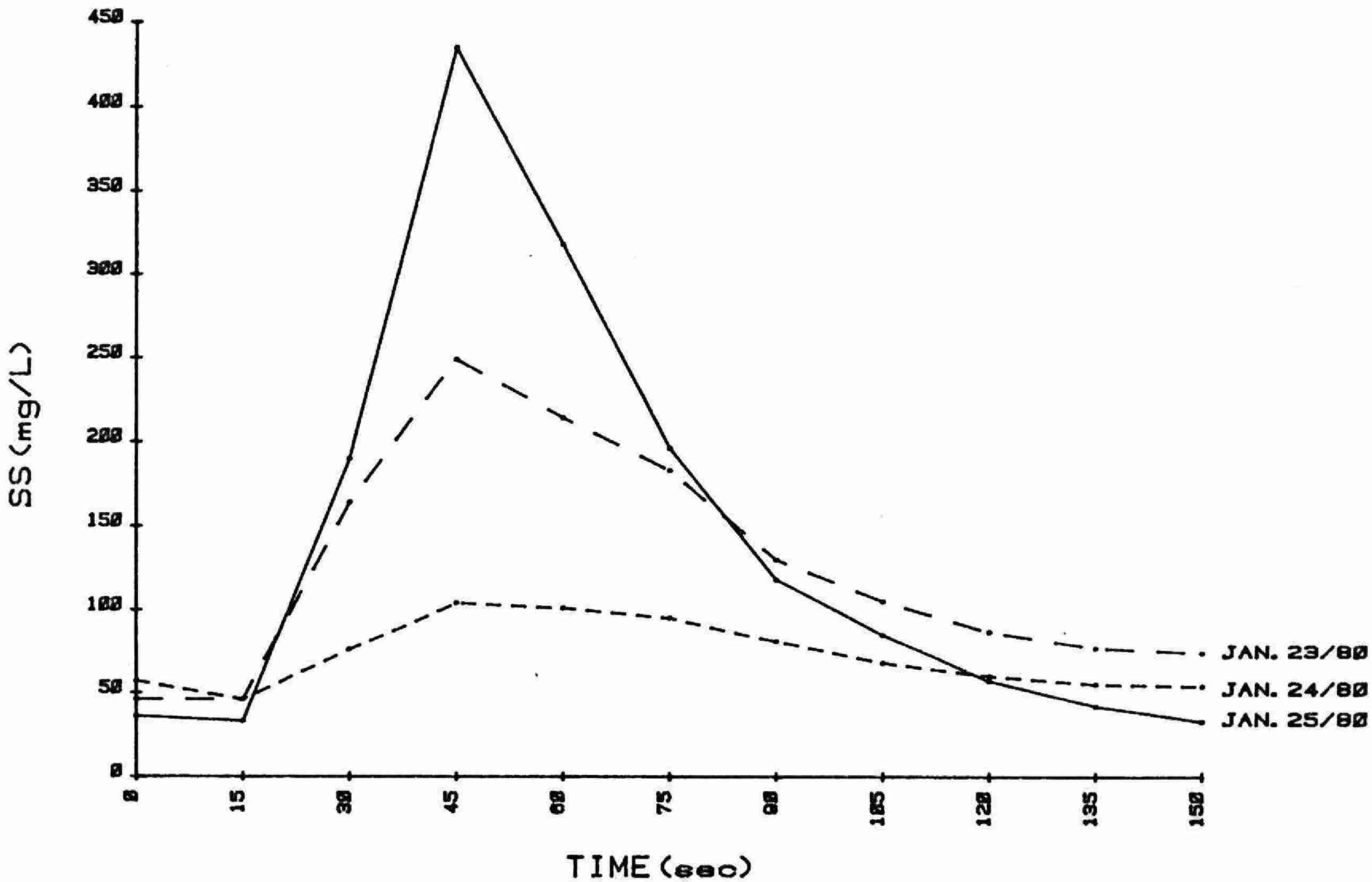



FIG 13.: Backwash water suspended solids concentration obseved on three separate occasions during the backwash of individual filter compartments.

## 5.3 Long-Term Performance

### 5.3.1 Quality Of Effluent

Once the intensive monitoring program was terminated the filter was left to operate for a further three months. Several sets of filter influent and effluent grab samples were taken and analyzed for suspended solids as shown in Table III.

Table III - Filter Influent And Effluent Suspended Solids Analysis Based On Grab Samples, March - May, 1980

| DATE 1980 | INFLUENT S.S. mg/L | EFFLUENT S.S. mg/L | COMMENTS |
|---|---|---|---|
| MARCH 18 | 8 | 2 | |
| MARCH 21 | 711 | 19 | SOLIDS CARRY-OVER IN CLARIFIER |
| MARCH 24 | 8 | 2 | |
| MARCH 28 | 6 | < 1 | |
| MAY 12 | 7 | 3 | |
| MAY 14 | 4 | 1 | |

### 5.3.2 Mechanical Reliability

No breakdowns were documented during the unattended operating period February to May 1980.

5.3.3 Examination Of The Media

A core sample of filter media was taken on December 20, 1979 when the filter was drained. The sample showed relatively clean sand topped with a 10 mm to 30 mm layer of dark brown sludge material. Microscopic examination of the material found that sand grains and sludge had formed cohesive lumps. There was no evidence of organic matter or biological growths other than in the top layer of filter sand.

On August 7, 1980 the filter was removed from the Burlington Skyway WPCP. The media was removed from the filter compartments by vacuum truck. Other than the clumps of sludge and sand on the surface of the media the sand was very clean. At the bottom of the compartments, however, dark sediment was noticed in a layer ranging in thickness from about 5 mm to 25 mm. This material was finely divided and consisted of organic and inorganic particles that presumably were not eliminated by the backwash action.*

* This observation was also independently confirmed during an effluent filtration study carried out in 1981 by Gore & Storrie Limited at the Barrie WPCP using the prototype ROTAHOOD filter.

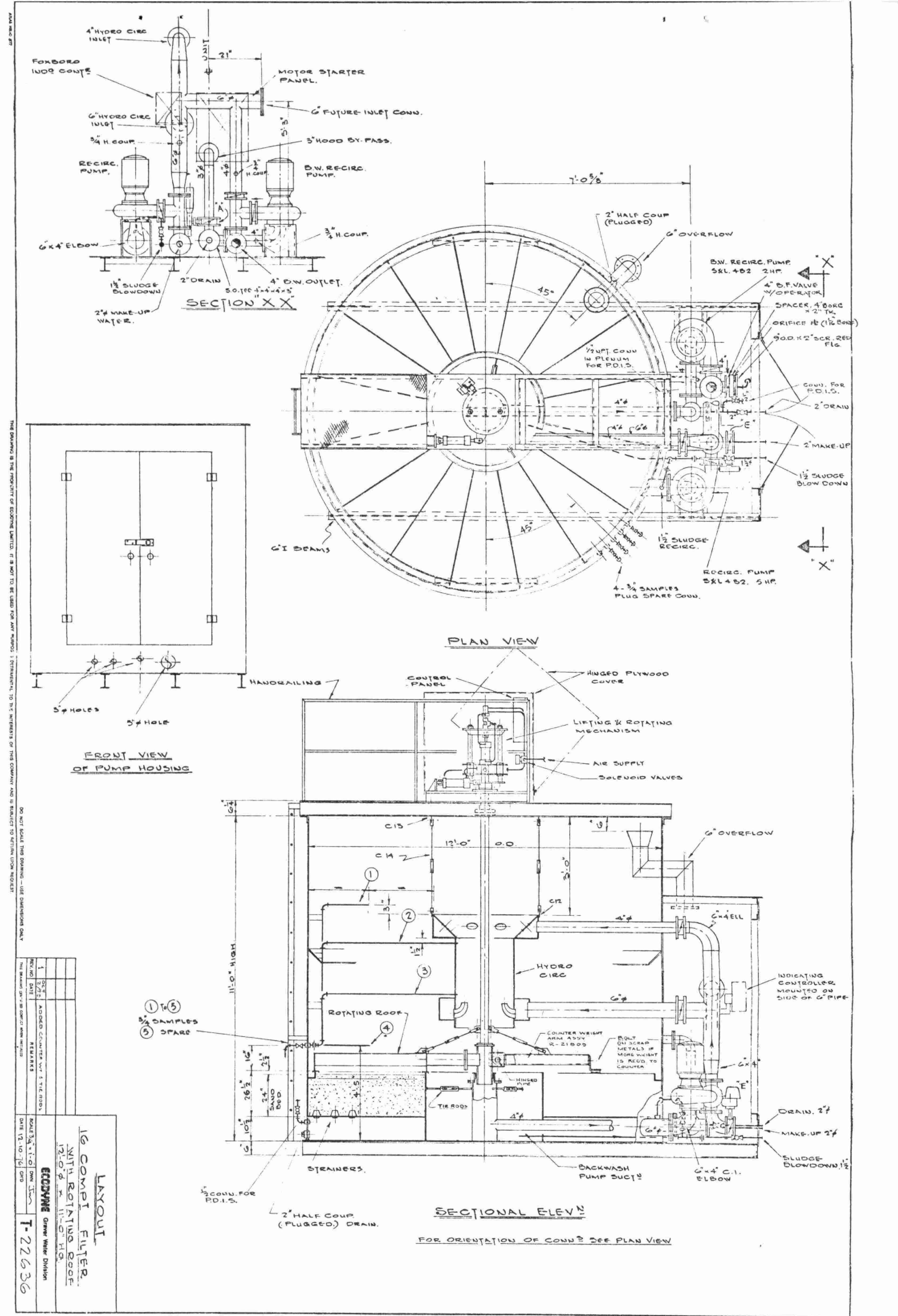
## 6.0 Conclusions

1. The prototype ROTAHOOD filter produced an effluent with suspended solids in the 1 mg/L to 4 mg/L range at a hydraulic loading of 3.8 m/h (78% of design) and solids loading of between 3.4 and 6.6 Kg $SS/m^2.d$ (97% to 189% of design).
2. The prototype ROTAHOOD filter produced an effluent with suspended solids in the 1 mg/L to 3 mg/L range at a hydraulic loading of 4.2 m/h (86% of design) and solids loading of between 0.5 and 1.0 Kg $SS/m^2.d$ (14.5% to 29% of design).
3. The prototype ROTAHOOD filter was able to recover from shock overloads with suspended solids without operator assistance. In order to achieve this capability the filter was modified (for details see Section 4.2) and operated with an effluent standpipe to maintain positive pressure in the common plenum chamber during backwash.
4. The length of the filter runs varied between 1.5 h (influent suspended solids of 193 mg/L) and 8 h (influent suspended solids of 5 mg/L).
5. For the operating conditions encountered, backwash volumes constituted between 2.7% and 39.9% of the total volumes processed. It must be noted that the prototype ROTAHOOD filter as tested was not optimized in design or operation for volumetric efficiency.

6. Examination of the media showed that backwash action was adequate to clean the bulk of the filter sand of accumulated solids. However, fine sediment tended to accumulate on the filter plate in areas between the strainers. The backwash flow was apparently unable to provide sufficient scouring action in these areas to dislodge settled out matter.

7. The ROTAHOOD filter control equipment was subject to failure due to climatic and exposure related influences during Phase I of the evaluation. Remedial steps taken by the manufacturer were effective in eliminating further service interruptions and mechanical failures during Phase II and the long-term performance trial.

# APPENDIX I


4" HYDRO CIRC INLET
FOXBORO IND? CONT?
MOTOR STARTER PANEL.
21"
6" FUTURE INLET CONN.
6" HYDRO CIRC INLET
3/4 H. COUP.
3" HOOD BY-PASS.
RECIRC. PUMP.
B.W. RECIRC. PUMP.
3/4" H. COUP.
6" x 4" ELBOW
1 1/2" SLUDGE BLOWDOWN
2" DRAIN
S.O. TEE 4"x4"x4"x3"
4" B.W. OUTLET.
2" Ø MAKE-UP WATER.
SECTION "X X"
7'-0 5/8"
2" HALF COUP (PLUGGED)
6" OVERFLOW
B.W. RECIRC. PUMP S&L 4B2 2HP.
"X"
4" B.F. VALVE W/OPERATOR
SPACER, 4" BORE x 2" TK.
ORIFICE PL (1 1/2" BORE)
9" O.D. x 2" SCR. RED FLG.
45°
1/2 NPT. CONN IN PLENUM FOR P.D.I.S.
CONN. FOR P.D.I.S.
2" DRAIN
4" Ø
2" MAKE-UP
1 1/2" SLUDGE BLOW DOWN
"E"
6" I BEAMS
1 1/2" SLUDGE RECIRC.
RECIRC. PUMP S&L 4B2. 5 HP.
4 - 3/4 SAMPLES PLUG SPARE CONN.
PLAN VIEW
5" Ø HOLES
5" Ø HOLE
FRONT VIEW OF PUMP HOUSING
HANDRAILING
CONTROL PANEL
HINGED PLYWOOD COVER
LIFTING & ROTATING MECHANISM
AIR SUPPLY
SOLENOID VALVES
C13
C14
12'-0" O.D.
3'-0"
6" OVERFLOW
C12
4" Ø
6" x 4" ELL
11'-0" HIGH
HYDRO CIRC
INDICATING CONTROLLER MOUNTED ON SIDE OF 6" PIPE
6" Ø
ROTATING ROOF
1 to 5 3/4 SAMPLES
5 SPARE
COUNTER WEIGHT ARM ASSY R-21503
BOLT ON SCRAP METALS IF MORE WEIGHT IS REQD. TO COUNTER
6" x 4"
"E"
HINGED PIPE
TIE RODS
24" SAND BED
DRAIN, 2" Ø
MAKE-UP 2" Ø
SLUDGE BLOWDOWN 1 1/2"
STRAINERS.
BACKWASH PUMP SUCT?
6" x 4" C.I. ELBOW
1/2 CONN. FOR P.D.I.S.
2" HALF COUP (PLUGGED) DRAIN.
SECTIONAL ELEV?
FOR ORIENTATION OF CONN? SEE PLAN VIEW
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DO NOT SCALE THIS DRAWING – USE DIMENSIONS ONLY
REV. NO. | DATE | REMARKS
1 | ADDED COUNTER WT & TIE RODS
LAYOUT
16 COMPT FILTER
WITH ROTATING ROOF
12'-0" Ø x 11'-0" HG.
ECODYNE Graver Water Division
SCALE 3/4"=1'-0
DATE 12-10-76
T-22636

| | DATE DUE | | |
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